

PATENT SPECIFICATION

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(19)



(54) MOORING TERMINAL

(71) We, SINGLE BUOY MOORINGS INC., a Corporation incorporated in accordance with the laws of Switzerland, of 12 Rue Abbe Bouet, 1701 Fribourg, Switzerland do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to a mooring terminal for mooring, permanently or temporarily a ship for the purpose of loading or unloading bulk cargoes, whether or liquid, solid or liquid slurry nature and it is an object of this invention to provide an improved mooring terminal.

According to this invention, there is provided a mooring terminal comprising a seabed anchor, a surface buoy, a first link pivotably connected to the buoy and to the seabed anchor so as to permit relative rotation about respective horizontal axes at those points of pivotal connection, the first link being pivotably connected to the seabed anchor through a bearing permitting rotation of the link about a vertical axis, and a second link connected to the buoy and pivotably connected to a ship so as to permit relative rotation about a horizontal axis.

Suitably, the connection between the second link and the buoy permits relative rotation about an axis coplanar or substantially coplanar with the fore and aft axis of the ship.

The mooring terminal may comprise a vertical tubular tower secured to or integral with the anchor.

Preferably, the rotatable bearing comprises an annular chamber mounted on the exterior of the tubular tower, either the tower or the annular member comprising a rib lying in a horizontal plane and projecting towards a groove in the other, there being provided bearing members between the rib and the surface of the groove. Suitably, there are provided bearing members between the vertical surface of the rib and the facing

vertical surface of the groove, and bearing members between each horizontal surface of the rib and the facing horizontal surface of the groove.

Preferably, the rotatable bearing includes seals accessible from inside the tubular tower.

In a preferred embodiment of the invention, two annular seals are disposed between the annular member and the tubular tower both above the rib and the groove and below the rib and groove. Preferably, there are provided an inflatable seal ring between the tubular tower and the annular member above the annular seals above the rib and groove and a further inflatable seal ring between the tubular tower and the annular member below the annular seals below the rib and groove.

Embodiment of this invention will be now described, by way of example only, with reference to the drawings accompanying the Provisional Specification of which:-

Figure 1 is a part cross-section of a bearing included in both embodiment of this invention;

Figure 2A and Figure 2B are, respectively, a schematic side view and a partial plan view of an embodiment of this invention; and

Figure 3A and Figure 3B, are, respectively, a schematic side view and a fragmentary plan view of another embodiment of this invention.

In the embodiment illustrated in Figures 2A and 2B there is provided a tubular access and maintenance tower 1 secured to a tubular piled anchorage 2. Near to the seabed 3 there is pivoted to the tower 1 one end of a mooring arm 4 through a bearing assembly 5 which will be described in detail later. Numeral 4 denotes the position of the mooring arm at high water level whereas numeral 6 denotes its position at low water level.

The upper end of the mooring arm 4 is pivoted to a surface buoy 7 comprising two floats 8 between which the mooring arm 4 extends. The mooring arm 4 is, as can be seen in Figures 2A and 2B, pivoted to bearing

5 and the buoy 7 so as to permit rotation about respective horizontal axes to accommodate rotation of the mooring arm 4 when the seal level rises and falls.

- 5 A rigid mooring arm 9 of the A-frame type has corresponding ends 10 of the arms of the "A" pivoted to a ship 11 permanently secured thereby to the mooring terminal. The mode of securing the arm 9 to the ship 11 is such as to permit relative rotation about a horizontal axis. At the apex of the "A" the mooring arm 9 is secured to the buoy 7 by means of a bearing and thrust assemblies 12 which permits rotation about the fore and aft axis of the ship 11. The bearing and thrust assemblies 12 are carried by braces 13 which extend between the floats 8.

- The tower 1 includes a central loading pipe 14 provided at its upper end with a loading chute 15 and extending vertically downwards to a tunnel beneath the seabed. A conveyor system is provided to transfer solid material e.g. mineral material from the ship 11 to the chute 15 so that this solid material can fall through the pipe 14 to the tunnel.

- 25 The arm 4 does in fact consists of two parallel arms 16 (as can be seen in Figure 2B), which are cross braced and which are pivoted at their lower ends to short shafts 17 projecting from the bearing 5 and lying on a common axis 18.

- In use, vertical movements of the ship and of the float 7 due to changes of the water level due to tides or surges or pitching of the ship are accommodated by the horizontal bearings at the two ends of the mooring arm 4. Yaw is accommodated by the bearing 5 which also allows deliberate rotation of the ship 11 about the terminal for the purposes of bringing the ship 11 adjacent to another ship for loading or transferring to material. Roll is accommodated by the bearings 11.

- Figure 2A shows the position of the ship 11 at low and high water levels; storm surge level is indicated at 19.

- 45 Details of the rotatable bearing 5 are shown in Figure 1 and it will be seen that the bearing 5 comprises an annular member 20 which surrounds the tubular tower 1 and is in two parts, the line between the upper and lower parts being denoted at 21. A ring-like bearing made up of two parts 22 and 23 which are secured to the tower 1 and which between them define a groove 24 the base of which faces outwardly and which has two facing horizontal surfaces. A bearing member 25 is carried by the annular member 20 at the inner part of its central surface and has an inwardly projecting rib 26 which lies in a horizontal plane and faces the groove 24. Roller bearings 27 are provided between the vertical surface of the rib 26 and the facing vertical and cylindrical surface of the groove 25 whereas roller bearings 28 and 29 are provided between the upper and lower surfaces 28 and 29 of the rib 26 and the facing horizontal surfaces of

the groove 24. The parts 22 and 23 making up the inner bearing member are held in position by annular angle plates 30.

Two annular seals 31 and 32 are provided on each side of the bearing members and each seal is of the labyrinth lip type which requires compression for its action and may be, for example, a Chevron seal. The seals 31 and 32 are not continuous and their ends are accessible from the interior of the tower 1 through holes in the tower 1 covered by plates 33. Above the seals 31 and 32 above the bearing members there is provided an inflatable seal ring 24 and a similar seal ring 33 is provided below the seals 31 and 32 below the bearing members. The seal rings 34 are only inflated in an emergency for which purpose there is provided a pneumatic source within the tower 1 connected to the seal rings 33 by pipes which are not shown.

Within the tubular tower 1 there are provided bracing members one of which is indicated at 35.

The shafts 17 extend through the wall of the bearing member 20 and are rigidly secured thereto. The tubular tower 2 is strengthened by rings 36.

In a modification for use with a liquid produce (not shown) the seabed anchorage 2 is of conventional shape and to it extends a seabed line rigidly connected to a hose (not shown) extending upwardly through the tower 1. At the upper end of the tower there is provided a product distribution unit in the form of a swivel from which a hose extends to the buoy, and, from there, to the ship.

In this modification, the buoy 7 is expanded and carries pumping equipment for pumping the fluid through the hose.

In the embodiment illustrated in Figures 3A and 3B, the buoy 7 is in the form of floats 45 rigidly secured to the end of the mooring arm 9 and in this case the mooring arm 4 is a central single arm bifurcated at its upper and lower ends. The upper end of the arm 4 is coupled to the mooring arm via a universal joint assembly 46 carried by cross bars 47 extending between the floats 45. In this arrangement the bifurcated ends of the arm 4 receive short stub shafts (not shown) which extend horizontally from a bearing member 48 forming part of the universal joint assembly 46 thereby permitting relative rotation about a horizontal axis. The member 48 itself is rotatable about a bearing member 49 carried by the cross bars 47 thereby permitting relative rotation about a vertical axis. In this arrangement no means are provided to permit rotation about an axis coplanar with the fore and aft axis of the ship so that this arrangement will not accommodate roll. There are however provided three horizontal axes about which relative rotation is permitted, that is at the upper and lower ends of the mooring arm 4 and at the point of coupling of the arm 7 to the boat 11 so that pitch is particularly well accommodated.

In Figure 3A personnel access is shown in the form of a ladder 50 leading to a catwalk 51 from which a man may enter the tower through an aperture 52.

- 5 In use, it would be expected that where a permanently moored ship is provided cargo will be transferred from a smaller ship to the holds of the permanently moored ship 11 with the two ships moored together. Where a
10 liquid product is to be transferred it may be course be transferred in either direction and a permanently moored ship may be used in such circumstances.

- 15 Where a permanently moored ship is provided a suitable dimension would be 50,000 ton dwt bulk carrier.

- 20 The buoyancy of the floats provides a resilient mooring system up to the design mooring loads applied in a survival storm condition for the case of a permanently moored ship.

- 25 The part of the tower 1 embedded in the seabed is designed to transfer the maximum design mooring load to the seabed rock sub-structure and is drilled and concreted into the seabed.

The upper part of the tower would normally carry fendering.

WHAT WE CLAIM IS:—

- 30 1. A mooring terminal comprising a seabed anchor, a surface buoy, a first link pivotably connected to the buoy and to the seabed anchor so as to permit relative rotation about
35 respective horizontal axes at those points of pivotal connection, the link being pivotably connected to the seabed anchor through a bearing permitting rotation of the link about a vertical axis, and a second link connected to the
40 buoy and pivotably connected to a ship so as to permit relative rotation about a horizontal axis.

- 45 2. A mooring terminal as claimed in claim 1, wherein the connection between the second link and the buoy permits relative rotation about an axis coplanar or substantially coplanar with the fore and aft axis of the ship.

3. A mooring terminal as claimed in claim 1, wherein the buoy is rigidly connected to the second link.

- 50 4. A mooring terminal as claimed in claim 3, wherein the first link is connected to the buoy so as to permit relative rotation about a vertical axis.

- 55 5. A mooring terminal as claimed in any preceding claim comprising a vertical tubular tower secured to or integral with the anchor.

- 60 6. A mooring terminal as claimed in claim 5 which comprises a fluid swivel unit mounted at the top of the tower and connected to a hose extending down the tower and to a hose

extending to the surface buoy.

7. A mooring terminal as claimed in any preceding claim, wherein the buoy incorporates pumping equipment.

8. A mooring terminal as claimed in claim 7 65 which comprises a conveyor system mounted at the top of the tower and a guide within the tower for transferring solid cargoes to the bottom of the tower.

9. A mooring terminal as claimed in claim 8, 70 comprising a chute for transferring solid material from the conveyor system to the guide which is tubular.

10. A mooring terminal as claimed in claim 8 75 or claim 9 which comprises a product transfer system disposed beneath or within the anchor for transferring product to a tunnel under the seabed.

11. A mooring terminal as claimed in any of 80 claims 5 to 10 wherein the rotatable bearing comprises an annular member mounted on the exterior of the tubular tower, either the tower or the annular member comprising a rib lying in a horizontal plane and projecting towards a groove in the other, there being
85 provided bearing members between the rib and the surface of the groove.

12. A mooring terminal as claimed in claim 11, wherein there are provided bearing members 90 between the vertical surface of the rib and the facing vertical surface of the groove, and bearing members between each horizontal surface of the rib and the facing horizontal surface of the groove.

13. A mooring terminal as claimed in claim 95 11 or claim 12, wherein the rotatable bearing includes seals accessible from inside the tubular tower.

14. A mooring terminal as claimed in claim 100 13, wherein two annular seals are disposed between the annular member and the tubular tower both above the rib and the groove and below the rib and groove.

15. A mooring terminal as claimed in claim 105 14 which comprises an inflatable seal ring between the tubular tower and the annular member above the annular seals above the rib and groove and a further inflatable seal ring between the tubular tower and the annular member below the annular seals below the rib and groove. 110

16. A mooring terminal substantially as herein described with reference to the drawings accompanying the Provisional Specification. 115

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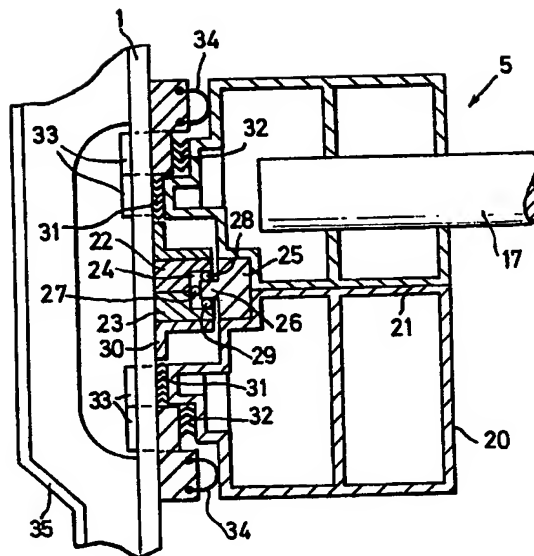
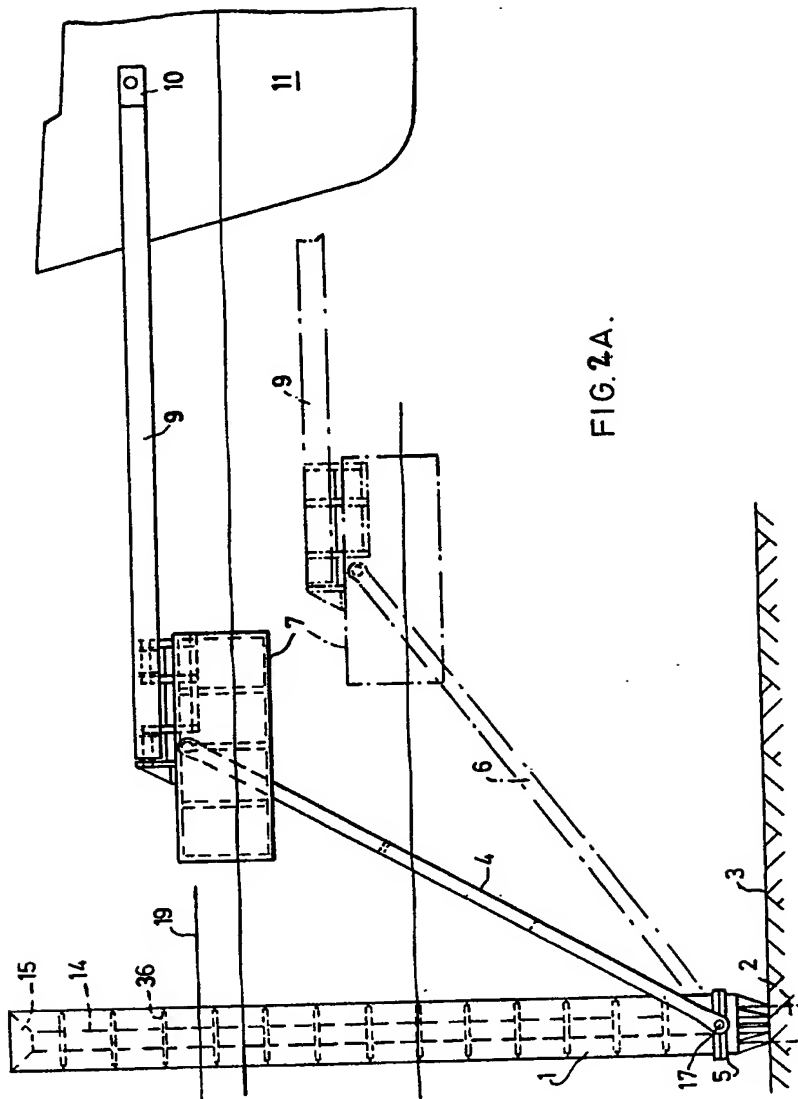


FIG. 1.

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Sheet 2



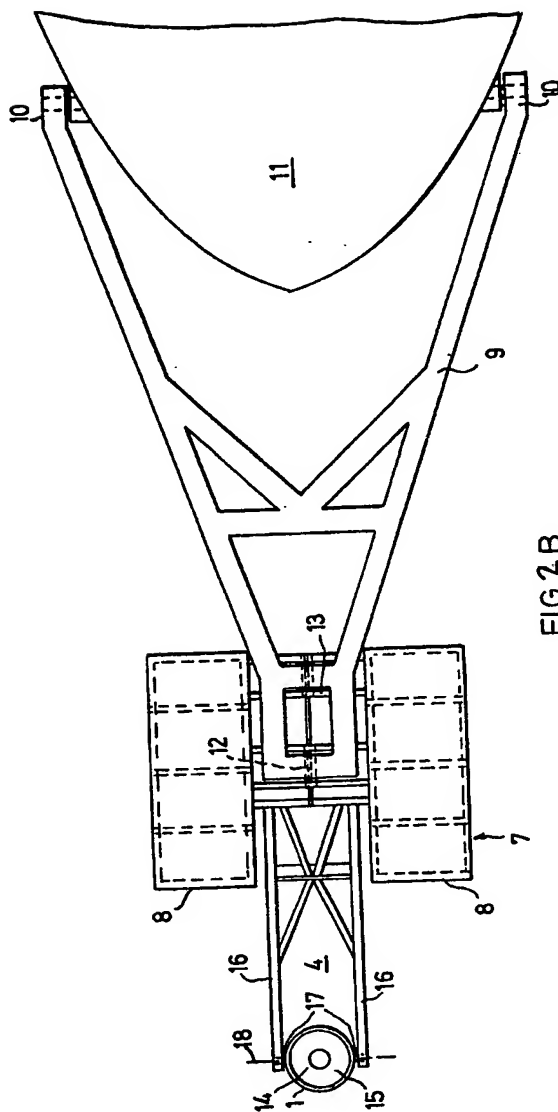
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Sheet 3



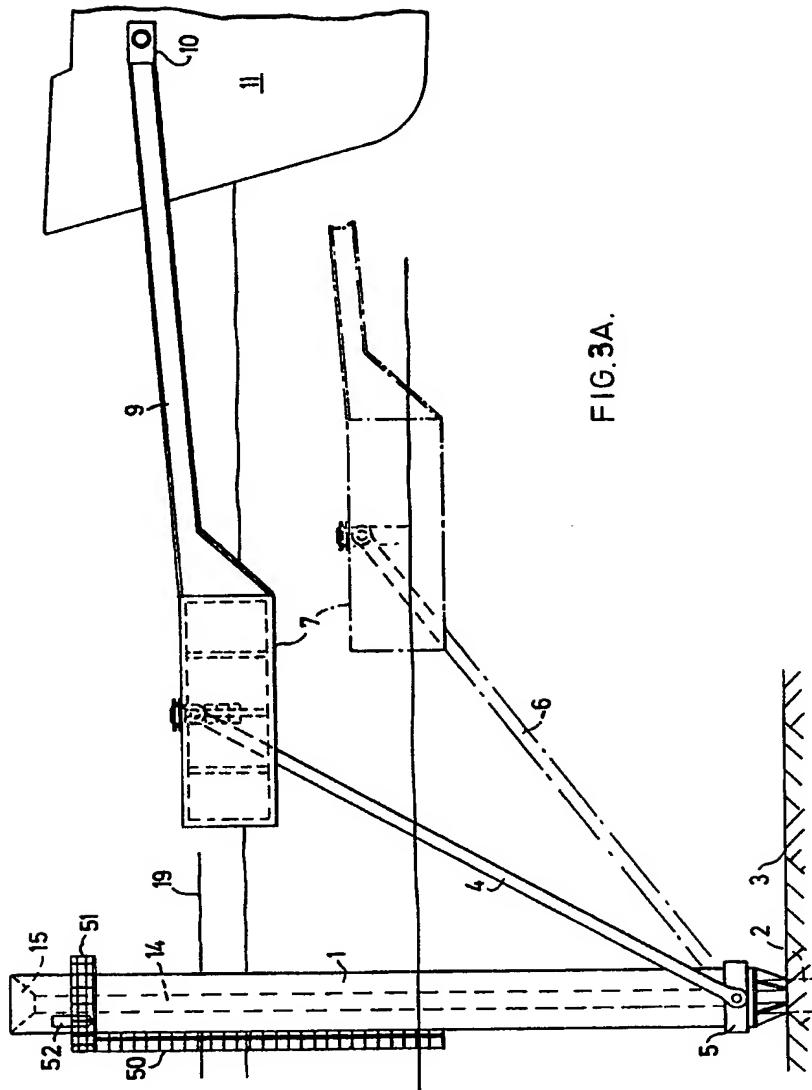
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